Appendix C

Glossary

Asymmetric (Common Mode) Interference

Common mode noise manifests itself as a current, which is in phase and magnitude, in the live and neutral wires of a circuit and returns via ground. This produces a noise voltage between live/neutral and ground.

See Noise, coupling

Attenuation

Attenuation is reduction in signal strength. Attenuation can occur naturally during the travel of the signal or it may be produced intentionally by inserting a device in the path of the signal to deliberately bring about a reduction in signal strength. The amount of attenuation is expressed in decibels or decibels per unit length. Attenuation is measured as a ratio of the incident signal and the signal passing through the barrier.

See Filter, EMI, RFI

Bandpass Filter

Bandpass filter is formed by combining a highpass filter and a lowpass filter so that a band of frequencies not stopped by either filter is not passed.

See Lowpass Filter, Highpass filter

Bandwidth

Bandwidth is a range of frequencies over which a certain phenomenon is to be considered.

Bleeder Resister

Bleeder Resistor is a high value, low wattage resistor (1/4 W or 1/2 W) connected across the input terminals of a filter. Bleeder Resistors serve two purposes: first to aid in voltage regulation, and second to prevent excessive voltages from developing across the capacitors when there is no load.

See Load

Capacitors

C(x)

C(x) capacitor is a capacitor, measured in micro farad and is used in the attenuation of noise. By increasing C(x), increases the insertion loss number. This is generally known for attenuating Line-to-Line noise (Differential Mode) at low frequencies.

See Attenuation, Differential Mode, Frequency, Insertion loss, Noise

C(y)

C(y) capacitor is smaller than C(x) capacitor measured in pico farad and is also used in the attenuation of noise. This is generally known for attenuating Line-to- Ground noise (Common Mode) at high frequencies. Generally, we eliminate C(y) for medical applications to reduce the leakage current.

See Attenuation, Common Mode, Frequency, Leakage Current, Noise

Choke

See Ground Choke

Common Mode

See Asymmetric Interference

Coupling

Coupling is a means of transferring energy from one stage of a circuit to another. A good example is a transfer of energy from the output of a circuit to a load.

See Electrical Coupling, Load, Magnetic Coupling.

Differential Mode

See Symmetric Interference

Electrical Coupling

Electrical coupling exists between, or among, any objects that show mutual capacitance. Electrical Coupling can be desirable, or undesirable. Two objects when electrically coupled, the charged particles on both objects exert a mutual attractive or repulsive force. The plates of a capacitor provide a good example of the effects of electric coupling. A negative charge on one plate produces a positive charge on the other, by repelling the electrons in the other plate and literally pushing them from it. A positive charge on one plate produces a negative charge on the other, by attracting extra electrons to that plate.

See Coupling

Electronic Load

Electronic Load is an electronic device designed to provide a load to the outputs of a power supply, usually capable of dynamic loading, and frequently programmable or computer controlled.

See Load, Load Impedance

Electro-Magnetic compatibility (EMC)

EMC is the ability of two or more electronic or electrical systems or units to co-exist without either disturbing the correct operation of the other. If this situation does not exist then one unit is said to be interfering with the other by providing conducted or radiated electromagnetic disturbance.

Electro-Magnetic Induction.

See Magnetic Coupling

Electro-Magnetic Interference (EMI)

EMI is an unwanted "noise" that affects the normal operation of a device. It can also be defined as an electromagnetic disturbance or phenomenon that interrupts, obstructs, degrades or limits the effective performance of electronic/electrical equipment.

See Noise

Electro-Magnetic Radiation

Electrical circuits carrying rapidly changing signals, as a by-product of their normal operation, emit electro-magnetic radiation causing unwanted signals (interference or noise) to be induced in other circuits.

See Noise

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Electro Static Discharge (ESD)

ESD is a transfer of electric charge between bodies of different electrostatic potential in proximity or through direct contact. With the advancement of new techniques to make integrated circuits much faster, smaller and lighter, the susceptibility to ESD has significantly increased. As more ICs are installed in sophisticated electronic systems, the ESD vulnerability of the host system has increased proportionally. ICs destroyed by ESD are easily detected because the input and output has been shorted or open-circuited. However, the devices that are just damaged show intermitted failures, degraded performance, or increased leakage current. This means that the damaged parts might pass the tests and be assembled into a system with a defect showing up only in the field, making their detection and replacement more costly and time consuming.

See Leakage Current, Susceptibility

Filter

A filter is a network able to discriminate between frequencies by passing signals in one frequency or frequency band while blocking signals outside that frequency or frequency band. Filters work by providing an impedance mismatch between the power line and the equipment, which reflects the noise back to its source. Therefore, to maximize this mismatch, an ideal filter should take into account the source and load impedances.

The filter comprises a network of chokes and capacitors. Separate chokes are connected in series with the Line and Neutral to reduce differential noise. Two chokes wound (same number of turns) on the same toroidal core are used to reduce common mode interference. Y class capacitors are connected between line/neutral and ground to attenuate common mode noise. They usually have low values to ensure that ground leakage is within specified safety limits and they are also tested to ensure that they do not fail closed circuit. X class capacitors are connected between the line and neutral conductors to reduce differential noise. Values of components are chosen to suit the source and load impedances. In addition a ground choke may be included to reduce common mode currents flowing in the earth conductor.

See C(x), C(y), Choke, Common Mode Noise, Differential mode Noise, Frequency, Impedance, Leakage Current, Load, Load Impedance

Ground

Electrical ground in an AC power system is a wire that is connected to the earth, hence the name "ground". The grounding in an electrical system is always required to protect users of electrical equipment from shock or to remove excessive noise in the system.

See Noise

Ground Choke

An alternate ground termination for the AC input power. This isolates AC mains' high frequency low impedance ground noise.

See Impedance, Noise

Ground Loop

An unintentionally induced feedback loop caused by two or more circuits sharing a common electrical ground.

Highpass Filter

Filters that allow higher frequency components or signals to pass while lower frequencies are attenuated.

See Attenuation, Filter

Hipot Test

Hipot is an acronym for High Potential, which means high voltage. Hipot test is performed by applying an excessive amount of voltage (AC or DC) intended to stress the product's insulation system. The Hipot test stresses the insulation between the current carrying and non-current carrying conductors of a product for excessive current leakage flow to ground. Usually the test voltage is equal to two times the product's operating voltage plus one thousand volts. For Example: if the product's operating voltage is 250 volts AC, then the test voltage should be (2 X 250) + 1,000 = 1,500 volts. Test voltages may also vary depending upon the classification of the product.

Impedance

Impedance is the resistance to alternating current (ac) flow. In ac circuits, the impedance depends not only on the resistance, but also on the reactance that depends on frequency.

Inductor/Coil (L)

Coil and Inductors are measured in milli Henries. Higher the L, better the performance of the filter. They perform differently at different current ratings. For example: at lower currents, they can attenuate common mode interference and as the current goes up, the inductance goes down and coil attenuates differential mode interference.

See Attenuation, Common Mode Interference, Differential Mode Interference

Insertion Loss

The loss resulting from the insertion of a device. Insertion Loss is a measure of the efficiency measured in decibels (dB). It is a reduction in the output voltage, current, or power of a system, resulting from an addition of an intermediary network such as a filter or attenuator. It is normally specified for the frequency, or band of frequencies, at which the attenuation is the least. Most selective filters have low insertion loss at the frequencies to be passed, and high loss at other frequencies.

If the output voltage of a circuit is V_1 before the insertion of a filter and V_2 after the insertion of a filter, the insertion loss L is given by

$$L = 20 \log_{10} (V_1/V_2)$$

Note: Line Filters always have a certain amount of insertion

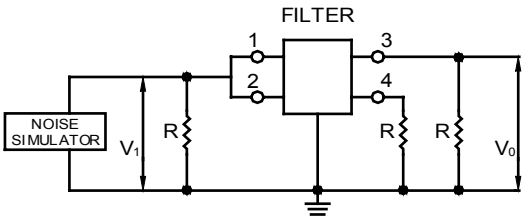
loss, but an efficient device normally exhibits less than one decibel of loss at the frequencies to be passed.

Ex: If V_1 is 50 millivolt and V_2 is 1 millivolt. The filter provides an insertion loss of 34dB.

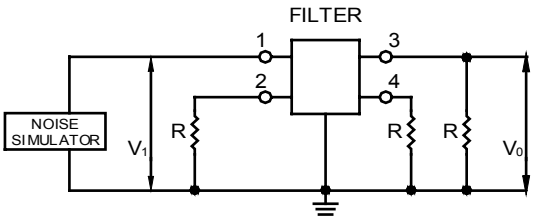
Insertion Loss (dB) = 20 $\log_{10}$ (50/1) = 34dB.

See Attenuation, Filter, Insertion Loss, Line Filter

INSERTION LOSS TEST



COMMON MODE
(L-G)



DIFFERENTIAL MODE
(L-L)

Leakage Current

The unwanted current leaking between two electrodes under voltage. Leakage current can occur with improperly grounded electrical equipment. Leakage currents are also relevant in the operation of semiconductor circuits, particularly at high temperatures.
Radiation damage can increase the leakage current, which translates into a decrease of the signal-to-noise ratio.

See Leakage Current, Signal-to-Noise Ratio

Line Side

Input side of the filter where power line is connected.

See Filter.

Line filters

Line Filters are used to suppress Radio-Frequency Interference (RFI) that is either generated by the host system (Emitted) or generated outside by other sources (Received).
Line filters can be placed in series with the ac power line cord from electronic equipment to attenuate RFI to an acceptable level, while permitting 50 or 60 Hz current to pass with little or no attenuation. It functions as a trap for RFI, preventing it from entering or leaving equipment. Line filters are made as dual, Lowpass networks with inductors typically in series and capacitors typically in parallel (See Fig. 1.1). Line filters are widely used in switching power supplies, computers, medical equipment, etc to suppress conducted RFI.

See Attenuation, EMI, RFI, Power Supply, Filter, Lowpass Filter

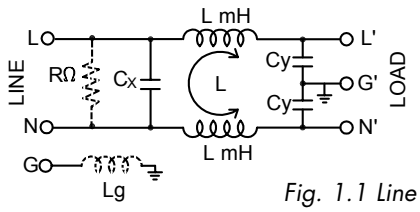


Fig. 1.1 Line Filter

See Filter, Load

Lowpass Filter

A Lowpass filter allows lower frequency components or signals to pass while higher frequencies are attenuated.

See Filter, Attenuation

Magnetic Coupling

Magnetic coupling exists between, or among, any objects that are present in the magnetic field. An Alternating current produces a changing magnetic field, which in turn produces changing currents in nearby objects. This happens when coils of wire are placed along a common axis. This form of magnetic coupling is called Electro-Magnetic Induction.

Modes of Propagation:

Radio frequency electromagnetic waves propagate, for the most part, via three methods: radiation, conduction, and induction. These interactions may occur individually or in combination.

1. Conducted Emission.Desired or undesired electromagnetic energy that is propagated along a conductor. This connection need not be direct; it can be via intermediary paths.
2. Radiated Emission. Desired or undesired electromagnetic energy that is propagated into or across space, either as a transverse electromagnetic wave or by capacitive or inductive coupling.
3. Inducted Emission. Desired or undesired electromagnetic energy that is induced from one conductor, either magnetically or by capacitive coupling, to another conductor. The two conductors do not need to be physically in contact with each other, as in the case of conduction. This form of interference commonly occurs when signal cables from various devices are routed parallel to each other in a common environment, such as within the same electrical conduit.

See Coupling, Electrical Coupling

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Appendix C

Noise

Noise is a broadband electromagnetic field generated by various environmental effects and man-made sources. Therefore, Noise can be natural or man-made.
While Cosmic disturbances, higher temperatures, lightning, etc are natural culprits of electromagnetic noise; man-made noise has also been on the increase. Any circuit or appliance that produces electric arcing will produce noise. Such devices include fluorescent lights, heating devices, electric motors, thermostats, etc. The level of electromagnetic noise affects the ease with which radio communication can be carried out. The higher the noise level, the stronger the signal must be if it is to be received.

Power Line Noise

A Power Lines for utility (60Hz) alternating current also acts as conduits for unwanted currents. These currents cover a wide spectrum and result in an effect power-line noise. The currents are usually generated by electric arcing at some point in the circuit. The broadband currents cause an electromagnetic field to be radiated from the power line because they flow in the same direction along the conductors. Some of the power-line noise can be attenuated with a line filter.

See Attenuation, Line Filter, Noise

Power Supply

A Power Supply is a circuit for converting alternating current or unregulated direct current to regulated direct current. The two principal categories of ac-to-dc power supply are linear regulated power supply and switched power supply.

Power Supply Filters

Power supply filters are used in ac-to-dc and dc-to-dc power supplies to smooth ripples or pulsations in the raw dc output.

See Filters, Power Supply

Radio Frequency Interference (RFI)

RFI is Electro-Magnetic Interference at higher (radio) frequencies. The frequency ranges of concern are 10KHz to 30KHz for conducted and 30MHz to 1GHz for radiated noise. RFI in most places is used as synonyms to EMI though this is somewhat of a misnomer as EMI covers a wider range of frequencies. RFI can be conducted through a power line in two modes: asymmetric or common mode (measured between line and ground), and symmetric or differential mode (measured from line-to-line)
ESD generated RFI could be reduced by removing the charge generating mechanism or by providing a method to bleed off the charge.

See Asymmetric (Common Mode), EMI, RFI, Symmetric (Differential Mode)

Signal-to Noise Ratio

The sensitivity of a communications receiver is specified in terms of the signal-to-noise ratio that results from an input signal of a certain number of microvolts. This ratio is abbreviated as S/N or S:N
If the root-mean square (rms) signal strength at the antenna terminals of a receiver is E_s, given in microvolts, and the rms noise level is E_n , also in microvolts, then the ratio S/N, in decibels, is

$$S/N = 10 \log_{10} (E_s/E_n)$$

Usually, the sensitivity is specified as the signal strength in microvolts that is necessary to cause a S/N ratio of 10 decibels.

Surge

Surge is an abnormally high voltage that is induced in a circuit once the power is turned on. The surge only lasts for a short period of time. This can be damaging to the circuit and/or appliance.

Susceptibility

The inability of equipment and/or system to perform without degradation in the presence of an electromagnetic disturbance.

NOTE: Susceptibility is a lack of immunity.

Symmetric (Differential Mode) Interference

Current flowing along either the live or neutral conductor, of a circuit, and returning along the other produces differential mode noise. A noise voltage is produced between the live and neutral conductors. Note that the currents in Live and Neutral are out of phase but have same magnitude.

See Noise

Wavelength

Wavelength is the distance between identical points of two adjacent waves. Wavelengths is a common way of describing light waves. It is denoted by Lambda (λ).

Wavelength = Speed of light in vacuum / Frequency.

The speed of light is the velocity of electromagnetic wave in vacuum, which is 300,000 km/sec.
A cellular phone with a frequency of 900MHz has a wavelength of 333mm (13”). The half wavelength and quarter wavelength will be 250mm (10”) and 83mm (3”) respectively. The cell phone will have the greatest effect on conductors that are 13” and 3” long.